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16. ABSTRACT

A uniform air pollution index for the U.S. is proposed. The index was developed from ten criteria identified in a survey of all the air pollution indices currently in use in the U.S. and Canada. The proposed index, named the Pollutant Standards Index (PSI), was designed to overcome the objections that some air pollution control agencies have raised about existing indices. PSI is a segmented linear function based on the National Ambient Air Quality Standards and Federal Episode Criteria. It is a "maximum" type index, reporting only the highest numerical value of all the sub-index values for each pollutant. There are four descriptor words reported with the index values.

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PRELIMINARY COMMUNICATION

# A PROPOSED UNIFORM AIR POLLUTION INDEX†

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## Introduction

Recently, several authors (NAS, 1975; Neidy and Dziewulski, 1973) have noted the variation in air pollution indices used by State and local governments to report daily air pollution levels to the public. We have just completed a compendium of all the air pollution indices currently in existence in the United States and Canada (Thom and Ott, 1975). This compendium, which is the most extensive compilation of index material currently available, further documents the diversity of air pollution indices. Although this compendium points to the need for a nationally uniform air pollution index, the task remains of developing an index formulation that combines most of the desirable features of existing indices. From the detailed analysis of the many air pollution indices examined in the Compendium, we have been able to identify the criteria that such an "optimum" index should possess.

Using these criteria, we have developed and now propose the Pollutant Standards Index (PSI), or $\Psi$, as a leading candidate for a nationally uniform air pollution index. We have designed PSI to overcome the serious objections that some air pollution control agencies have raised to existing indices. PSI is a segmented linear function based on the National Ambient Air Quality Standards and the Federal Episode and Emergency Criteria. It is a "maximum" type index, reporting only the highest numerical value of all the sub-index values for each pollutant. There are four descriptor words reported with the index values.

## Air Pollution Index Criteria

The following gives the ten criteria identified in the Compendium and discusses the way in which PSI meets these criteria.

Easily understood by the public - PSI transforms the scientific concentration units of each pollutant into a non-dimensional number which is easily understood by the public. The index values are easily related to each pollutant's standard and episode criteria values.

† The Environmental Protection Agency and the Council on Environmental Quality are presently considering official publication of an air pollution index. The index presented herein does not necessarily represent the one which may be put forward by the governmental agencies by whom the authors are employed.

Not inconsistent with perceived air pollution levels - Inconsistency arises only with combined or aggregated indices. Since PSI calculates separate index values for each pollutant, this problem is circumvented.

Spatially meaningful - The spatial meaningfulness of PSI (or any index) depends on how the data are selected or manipulated before being used in the index computation. For example, a pollutant concentration averaged over several monitoring stations may be used, or the highest pollutant concentration from all stations in a city may be selected for the index calculation. It is recommended that the latter method be used to prevent the masking of high pollutant concentrations resulting from the averaging process.

Includes major air pollutants and capable of including future pollutants - PSI can be calculated for all pollutants for which National Ambient Air Quality Standards (NAAQS) and Episode Criteria have been established. In order to include new pollutants in the PSI structure, one need only draw another curve based on the new pollutant's NAAQS and Episode Criteria.

Calculated in a simple manner using reasonable assumptions - Once the PSI curve is plotted (see Figure 1), the PSI values are obtained for any pollutant concentration by simply reading them from the appropriate curve. These values are based on a linear interpolation between the curve breakpoints, as defined for each pollutant by the primary NAAQS and Episode Criteria values (see Table 1).

Rests on a reasonable scientific basis - Since PSI converts the pollutant concentration values of the Standards and Episode Criteria into a non-dimensional number using a simple linear interpolation calculation method, its basis is as solid, but no more solid, than the scientific basis on which the Standards and Episode Criteria were established.

Relates to ambient air quality standards and goals - For each pollutant, an index value of $\psi = 100$ is equivalent to the primary NAAQS. In those cases where a secondary NAAQS exists, $\psi = 50$ (see Table 1); otherwise 50 designates 50 percent of the primary standard.

Relates to episode criteria - For each pollutant, PSI relates to the Episode Criteria in the following way: Alert, 200; Warning, 300; Emergency, 400; Substantial Endangerment, 500.

Exhibits day to day variation - Since PSI is calculated for each pollutant separately and the maximum value reported, daily variation occurs both in PSI and in the pollutant reported. Reporting the maximum actual pollutant concentrations (or the ratio of pollutant concentration to the NAAQS) gives pollutant variation but does not give the large numerical variation necessary for the index value to be clearly understood by the public, because the number appears as a fraction.

Can be forecast a day in advance (optional) - Although 24-hour advance index forecasting will be difficult without extensive meterological data, qualitative index forecasting is possible using the National Weather Service's Air Pollution Weather Forecast Program. These data allow an 18-hour forecast of index values by using the following word descriptors: "remain the same," "decrease," or "increase." It must be emphasized that these descriptors are only qualitative, and, as such, they indicate only the expected trend of the index value during the forecast period.

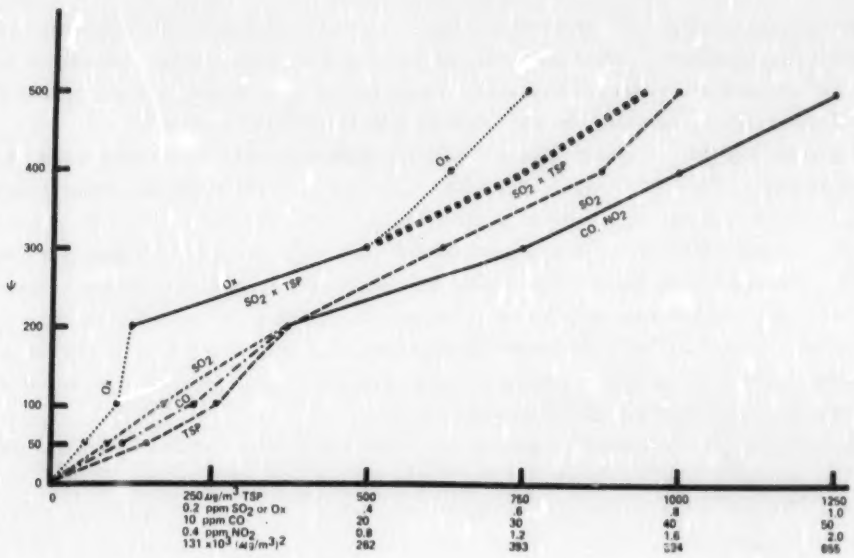


FIGURE 1 THE PSI INDEX FUNCTION PLOTTED vs POLLUTANT CONCENTRATION

## TABLE 1 BREAKPOINTS FOR PSI

| | Ψ | CO ppm | $SO_2$ ppm | TSP $\mu g/m^3$ | $SO_2$ x TSP $(\mu g/m^3)^2$ | $NO_2$ ppm | Ox ppm |
|---|---|---|---|---|---|---|---|
| Averaging Time (hours) | NA | 8 | 24 | 24 | NA | 1 | 1 |
| 50% of Primary NAAQS | 50 | 4.5 | 0.07 | 150[a/] | b/ | b/ | 0.04 |
| Primary NAAQS | 100 | 9 | 0.14 | 260 | b/ | b/ | 0.08 |
| Alert | 200 | 15 | 0.3 | 375 | 65,000 | 0.6 | 0.10 |
| Warning | 300 | 30 | 0.6 | 625 | 261,000 | 1.2 | 0.40 |
| Emergency | 400 | 40 | 0.8 | 875 | 393,000 | 1.6 | 0.50 |
| Significant Harm | 500 | 50 | 1.0 | 1,000 | 490,000 | 2.0 | 0.60 |

a/ Secondary NAAQS

b/ No NAAQS exists -- PSI is not reported below the Alert level.

## Basic Structure of PSI

Number of Pollutants. PSI incorporates only those air pollutants for which uniform NAAQS or Episode Criteria exist: carbon monoxide, sulfur dioxide, suspended particulate matter, nitrogen oxides, and photochemical oxidants. Because of its structure, any additional future NAAQS pollutants can accommodated by PSI without modifying PSI's basic form.

Calculation Method. A linear function with nonconstant coefficients (segmented linear function) is used. The PSI breakpoints (Table 1) are based on the NAAQS and Federal Episode Criteria. A plot of each set of values gives a PSI function for each of the five pollutants (Figure 1). If new NAAQS are adopted in the future, a new PSI function can easily be drawn.

Mode. Because PSI is based on the NAAQS and Episode Criteria, which do not include standards for the combinations of pollutants (except the product $SO_2$ x COH), the index can be either an "individual" or "maximum" mode. When the maximum mode is used, only one pollutant sub-index is reported. Using the individual mode, sub-index values for each pollutant equal to or exceeding the primary NAAQS are reported.

Descriptor Words. Four words, based on the NAAQS and Federal Episode Criteria, are used to describe pollution levels: "Good," 0-50; "Satisfactory," 51-100; "Unhealthful," 101-199; "Hazardous," 200-500. "Hazardous" describes air pollution levels at and above the Alert Level to prevent confusion when pollution levels exceed this level but an Alert is not called.

## Conclusion

The basic structure of PSI will result in short index reports which are ideal for radio or television; e.g., "Today PSI equals 56; the air is Satisfactory." However, a more extensive description of the PSI values is desirable for reports given in newspapers or telephone recordings. In this case, more detailed descriptor phrases are available, as shown in the following example in which $\Psi$=56: "The PSI index value for the 8 to 9 a.m. period today was 56 for photochemical oxidants. Index values between 51 and 100 indicate Satisfactory air quality. However, sensitive persons may experience discomfort during outdoor activity."

We believe that the PSI formulation offers the greatest chance for acceptance by State and local air pollution control agencies. Adoption of a nationally uniform air pollution index should (1) facilitate comparisons of air quality levels in different cities, (2) reduce confusion among residents of cities about daily air quality levels, and (3) provide policy makers with a uniform measure for evaluating the impact of regulatory actions.

## References

1. NAS (1975), National Academy of Sciences, "Planning for Environmental Indices" Report of the Planning Committee on Environmental Indices to the Environmental Studies Board.

2. Reidy, M. and Dziewulski, C. (1973), "Homogeneous Dissemination of Ambient Air Quality Levels to the News Media on the Public or the Need to Eschew Obfuscation," Paper #73-352 presented at the 66th Annual Meeting of the Air Pollution Control Association, Chicago, Ill.

3. Thom, G. C. and Ott, W. R. (1975), "Air Pollution Indices: A Compendium and Assessment of Indices Used in the United States and Canada," Joint Study sponsored by the Council on Environmental Quality and the U.S. Environmental Protection Agency, in press.